With respect to hazardous air pollutants, the NWTC may, from time to time, emit acetone, cyclohexane, toluene, xylene, phosphoric acid, and sulfuric acid. The emission quantities are extremely small and use is infrequent. The actual emissions are well below permit and notification thresholds.

Table 3-2. Annual Emissions at the NWTC (Tons Per Year), 2001

	Particulates	SO2	NOx	CO	TOC
Potential to Emit	6.39	5.97	91.04	19.59	7.21
Actual Emissions	0.18	0.17	2.52	0.54	0.20

Source: Compiled from NWTC November 2001 emissions inventory

* Total Organic Compounds (TOCs) are volatile organic compounds plus carbon monoxide, carbon dioxide, carbonic acid, and metallic carbides.

3.3.4 NWTC Permit Status

After reviewing the CAQCC regulations, the NREL determined that submission of APENs associated with site operations is not required. An APEN was recently submitted to the CAQCD in preparation for construction activities associated with the Proposed Action. The CAQCD issued Permit No. 00JE0010L in March 2000, which expires January 31, 2005. NREL also submitted a fugitive dust plan for land development that addresses measures to be taken during construction activities. Fugitive dust consists of emissions that are unplanned and escape from a process by a route other than a stack, chimney, or vent. In cooperation with CDPHE, NREL is in the process of determining whether other permits are necessary.

3.4 NOISE

Noise is defined as unwanted or annoying sound that is typically associated with human activities and that interferes with or disrupts normal activities (Salter, 2000). Sound and noise are measured as sound pressure levels in units of decibels (dB). Response to noise varies according to its type, its perceived importance, its appropriateness in the setting and time of day, and the sensitivity of the individual receptor. Human hearing is simulated by measurements in the A-weighting (dBA) network, which de-emphasizes lower frequency sounds to simulate the response of the human ear. Some typical sound levels from common noise sources are presented in Table 3-3.

Table 3-3. Sound Levels* of Typical Noise Sources and Noise Environments (A-weighted Sound Levels)

Noise Source (at a given distance)	Scale of A-weighted Sound Level (dBA)	Noise Environment (equivalent)	Human Judgment of Noise Loudness (relative to a reference loudness of 70 dB*)
Commercial jet take-off [200 feet (60.6 meters)]	120		Threshold of pain *32 times as loud
Motorcycle [25 feet 7.6 meters)] Diesel truck, 40 mph [50 feet (15.2 meters)]	90	Boiler room Printing press plant	*4 times as loud
Garbage disposal [3 feet (1 meter)]	80	High urban ambient sound	*2 times as loud
Passenger car, 65 mph [25 feet (7.6 meters)], Vacuum cleaner [3 feet (1 meter)]	70		Moderately loud *70 dB (Reference loudness)
Normal conversation [5 feet (1.5 meters)]	60	Data processing center Department store	*1/2 as loud
Light traffic [100 feet (30 meters)]	50	Private business office	*1/4 as loud
Bird calls (distant)	40	Lower limit of urban ambient sound	Quiet *1/8 as loud

* These values are logarithmic measurements (i.e., every 10-dBA increase is perceived by the human ear as approximately twice the previous noise level; therefore, the motorcycle is twice as loud as the garbage disposal). Sound level intensity decreases by approximately 6 dBA for each doubling of distance from the source. Further reduction occurs when sound energy travels far enough to be appreciably reduced by absorption.

Source: U.S. National Park Service and Salter, 2001

3.4.1 Sensitive Receptors

There are no sensitive human noise receptors, such as residences, schools, hospitals, or daycare centers located in the immediate vicinity of the NWTC. The nearest residence to the NWTC is approximately 2,200 feet (667 meters) due west of the western site boundary and approximately 150 feet (45.4 meters) west of Highway 93. There are no other residences within a 4-mile (6.4 kilometers) radius of the site. Two City of Boulder Open Space parking areas and trailheads are also located near the site. The Green Belt Plateau trailhead is located immediately north of Highway 128 and is slightly less than 4000 feet (1212 meters) north of the site. The Flatirons Vista trailhead is located immediately west of Highway 93 approximately 5,000 feet (1515 meters) northwest of the NWTC. The relationship between noise and wildlife is discussed in Section 4.8.4 Wildlife.

3.4.2 Noise Sources and Existing Noise Levels at Sensitive Receptors

Two primary noise sources in the vicinity of the NWTC are State Highways 128 and 93. Highway 128 is located north of the NWTC. State Highway 93 is located west of the NWTC. Roadway noise depends upon vehicle type, speed, traffic volume, surface conditions, surface gradient, and distance between source and receptor. Passenger cars moving at 65 mph can generate 70 dBA, measured at 25 feet (7.6 meters) (U.S. National Park Service website).

Traffic on the NWTC contributes little to overall traffic noise at off-site locations because of the limited number of vehicles that access the site, speed limits restricting high vehicle speeds.

Another noise source in the vicinity is the aggregate mining and processing facility located immediately west of the site, between the NWTC and Highway 93. Industrial processes and equipment generate continuous and intermittent noise, which fluctuates depending on the level of activity at the site.

The NWTC is also a noise source in the vicinity. Noise generated from wind turbines on the NWTC and other activities on the site contribute incrementally to existing noise levels generated by other sources. Turbine operations create intermittent noise while in operation on various test sites. Currently, there are 21 test sites and use of these sites for turbines varies in terms of location and operational schedule. Noise is also generated from high-lift and support equipment when turbines are installed or removed. This noise is very temporary and may be considered equivalent to the noise generated by construction operations.

The two potential sources of operational noise from a wind turbine are mechanical noise from the gearbox and aerodynamic noise from the rotor blades. Mechanical noise has virtually disappeared from modern wind turbines as a result of engineering designs that minimize vibrations. Aerodynamic noise results from blade design and rotational speed. Blade tips and back edges are currently designed to minimize aerodynamic noise associated with higher rotational speeds (Danish Wind Turbine Manufacturers Association web site, 2001). Noise resulting from moving blades is characterized by low frequencies and are, therefore, less obvious to the human ear. Slower moving blades create less noise.

Sound level measurements obtained from representative turbines that have been and/or could be installed at the NWTC under current operational parameters are shown in the Table 3-4.

As shown in Table 3-4, larger turbines of the megawatt class do not necessarily produce more noise than small turbines (NWTC, Johnson, 2001). In this example, the data suggest that noise produced from the 50-kilowatt turbine would measure approximately 73.5 dB at a distance of 300 feet (91 meters), which is higher than the noise generated by either of the two larger turbines.

Table 3-4. Representative Sound Levels Generated by Individual Turbines

Rated Capacity (kilowatts)	Typical Sound Levels (dB)	Measurement Distance *
50	82.5	104.5 (31.7 meters
750	68	347 (106.2 meters)
1,500	60	307 (93 meters)

* Aerodynamic noise generated by turbine operations is measured at a specified distance from the base of the tower. The distance is obtained by summing the installed height of the turbine (from ground level to the hub) plus the length of one rotor blade (half of the total rotor diameter).

Rated Capacity (kilowatts)	Typical Sound Levels (dB)	Measurement Distance
50	73.5	300 (91 meters)
750	69	300 (91 meters)
1,500	60	300 (91 meters)

Source: NWTC, Johnson, 2001

Although noise measurements were not taken and noise modeling was not completed in association with the development of this document, estimates have been made to characterize the ambient noise levels on the site and in specific off-site locations. The ambient noise level at the NWTC consists of sound generated by on-site and off-site vehicle traffic, turbine operations, aggregate mining and processing activities, and natural sources, such as birds and wind moving through trees and across the terrain. When no turbines are operating, the acoustic environment within the boundaries of the site area is typical of a rural location, with day-night average sound levels ranging from 35 to 56 dBA (Final EIS on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site, 1998), depending on specific circumstances. Actual noise levels in and around the site are affected by specific noise events, proximity to noise sources, intervening topography, vegetation, and meteorological conditions, including wind speed and direction.

In order to further characterize the existing noise environment, certain turbine operational assumptions must be made. This is complex because the NWTC turbine schedules are not pre-defined nor are specific locations for particular kinds of turbines. To establish estimates for maximum noise level generation, it has been assumed that the noise level generated by the site would need to account for simultaneous turbine operation at numerous test sites using the noisiest turbines and some mix of other turbines. For this discussion, it has been assumed that a noise level of 85 dB could be produced at a point located 100 feet from the base of the operating tower nearest to a specified receptor under worst-case conditions (NWTC, Johnson, 2001). The 85-dB noise level is slightly higher than the maximum noise level generated by the single, most noise-generating turbine on the NWTC (see Table 3-4). This level would be unusual and would not be sustained all day or for extended periods of time in a given week, month or year because of normal variations in wind speed and typical testing periods at the NWTC.

Table 3-5.displays noise levels associated with increasing distance from an 85-dB source.

Table 3-5. Combined Representative Sound Levels Generated by Turbines

Distance feet (meters)	dB
100 (30.6)	85
200 (60.6	79
400 (121.2)	73
800 (242.4)	67
1600 (484.8)	61
3200 (969.6)	55
6400 (1939.2)	49

Source: O'Hare Noise Compatibility Commission, 2001.

The estimated noise resulting solely from these assumed turbine operation conditions would be as follows:

- Nearest residence: approximately 59 dB, or slightly less than the noise resulting from normal conversation.
- Flatirons Vista Trailhead: approximately 52 dB, slightly more than the noise apparent in a business office.
- Green Belt Plateau Trailhead: approximately 50 dB, equivalent to the noise apparent in a business office or light traffic.

Note: These noise level estimates at off-site receptors were developed considering only the distance from the receptors to the nearest test sites to them. Other factors may reduce these levels further.

This incremental contribution would be insignificant relative to far higher existing highway noise levels and would be inaudible under most circumstances.

3.4.3 Regulations and Guidelines

Environmental noise regulations and guidelines for outdoor, neighborhood and/or community noise levels have been promulgated by the EPA, the Federal Highway Administration (FHWA), the State of Colorado, and local governments such as the City of Denver. Although these standards are not directly applicable to the NWTC, they provide a general context for assessing noise issues.

The EPA provides guideline noise levels in relation to anticipated noise/human activity disturbance impacts in relation to industrial construction and operations, below which the general public would be protected from activity interference and annoyance. Outdoor locations "in which quiet is a basis for use" are assigned a maximum noise level of 55 dBA. Indoor locations are assigned a maximum noise level of 45 dBA.

The FHWA has created Noise Abatement Criteria for actions that involve federal roads. A noise level of 57 dBA is assigned to lands on which "serenity and quiet are of extraordinary significance… and where the preservation of those qualities is essential if the lands are to continue their intended purpose." A 24-hour average level, weighted to address the increased significance of nighttime noise, of 67 dBA is a typical threshold for considering mitigation for residential sensitive receptor exposure.

Although the State of Colorado Noise Statute (CCR 25-12-101 though CCR 25-12-109) has established statewide standards for noise level limits for various time periods and areas, the standards exclude federal agencies such as NREL and non-profit entities; however, they can be used as guidelines in order to evaluate impacts. The most stringent permissible noise levels apply to residential zones, where the maximum permissible daytime (7:00 a.m. to next 7:00 p.m.) noise level is 55 dBA and the noise level is measured at a distance of 25 feet from the property line. In addition, construction projects are limited to permit conditions or 80dBA for the period within which the construction is to be completed (or reasonable amount of time).

The City of Denver has promulgated a noise ordinance that can provide another basis for ascertaining permissible noise levels. The type of premises on which the noise is generated determines allowable noise levels. In the case of the NWTC, the most conservative approach is to consider it an "industrial premises." The maximum allowable sound pressure level is 80 dBA measured at the site property line between the hours of 7:00 a.m. to 10:00 p.m. (Revised Municipal Code, City and County of Denver, Colorado, Ordinance No. 628-97, 22 September 1997, Supplement No. 55).

The DOE has accepted the Occupational Health and Safety Administration (OSHA) noise regulations and guidelines for worker exposure and manages compliance with them. These regulations and guidelines focus on noise from machinery, equipment and tools.

Noise levels generated by most turbines under normal operations at the NWTC are within recommended levels, but older and smaller models operating in an unusual manner (together over extended periods of time) could approach certain standards within site boundaries. No standards are reached or exceeded at any off-site sensitive receptors under any reasonable scenarios.

3.5 VISUAL QUALITY/AESTHETICS

3.5.1 Visual Characteristics of the Project Site and Vicinity

Figure 3-2 presents 21 photographs to characterize existing visual and aesthetic conditions of the site and vicinity from key vantage points. These photographs are presented at the end of Chapter 3 and are referenced throughout Chapter 3, as appropriate.

The visual characteristics of the site are created by permanent facilities, temporary or transient facilities, and natural conditions (see Figure 3-2, photographs 1-9). The permanent facilities are primarily composed of buildings, roads, parking areas and test sites. The temporary or transient facilities include wind turbines, meteorological towers and construction/maintenance equipment. Many of these facilities and pieces of equipment either move from place to place within the test site area or are not always on the site. However, turbines and towers would be considered permanent visual features on the site. Much of the test site area retains natural vegetation. A portion of the site is undeveloped and retains a natural appearance.

The tallest meteorological towers are located on test sites M-2 and M-3 (see Figure 1-3). They are 264 feet (80 meters) high. There are many others of lesser height. These shorter tower heights are in the 66 to 132 foot (20 to 40 meter) range. Turbine heights from ground to the blade hub vary. The highest current hub height is 120 feet (36.4 meters).

A mix of industrial facilities, grazing lands, and natural open space defines the visual character of the project vicinity, (see Figure 3-2, photographs 1, 2, 5, 6, and 9-21). Open lands and mountains, including the Flatirons within the Boulder Mountain Parks area, dominate the visual character of the area. Views of the continental divide through Eldorado Canyon, a State Park, are visible from vantage points on and near the NWTC (see Figure 3-2, photographs 1, 6, 9 and 10).

Local community planning efforts protect views of the Flatirons and the mountains to the south that form a striking feature in the landscape. This feature is referred to as the Mountain Backdrop by a cooperating group of local agencies (see Figure 3-2, photographs 1,6,9,10,15 and16). The vast majority of the resources protected by this effort are west of Highway 93. The protected resources in the project vicinity are west of Highway 93. The NWTC site and adjacent lands south and east of Highway 128 and 93, respectively, are not protected resources.

3.5.2 Public Vantage Points and Site Visibility

There are several primary off-site vantage points in the project vicinity where the general public can see the site and/or site facilities. Key vantage points along Highway 93 exist for southbound motorists north of the Highway 93/128 intersection and for northbound motorists south of the project site (see Figure 3-2, photographs 13 and 14). However, in many instances